Coalbed Methane Outreach Program
U.S. Environmental Protection Agency

Potential to Upgrade Gob Gas To Pipeline Quality

The U.S. EPA's Coalbed Methane Outreach Program (CMOP) published a final report entitled "Technical and Economic Assessment of Potential to Upgrade Gob Gas to Pipeline Quality" (the report). The report reviews technical and economic issues of the feasibility of removing contaminants from gob gas to a quality level that commercial natural gas pipelines will accept. The report suggests that gob gas enrichment (i.e. contaminant removal) is technically feasible and, under certain circumstances, financially desirable. Researchers encountered engineering firms that are attempting to install and demonstrate integrated enrichment facilities that can produce good quality methane for a cost that is less than its value in the marketplace.

The report discusses the opportunities for mining companies and project developers to profitably use gob gas that is currently underused because of the contaminants it contains. It traces the development of three different technologies capable of removing nitrogen, the most abundant and difficult contaminant to eliminate. The report discusses removal methods for three other substances: carbon dioxide, oxygen, and water. Using computer simulation techniques, the assessment modeled the process parameters of the competing commercial designs to measure effectiveness and estimate costs.

The report presents cost estimates for facilities that would operate at different flows, using a range of feed gas qualities. It also includes a user-friendly model that can help project developers decide if blending with pure methane and/or propane could economically supplement the capability of an enrichment facility.

Purpose of the Study

CMOP undertook this study because owners of gassy mines and natural gas developers have needed to find a cost-effective use for gob gas that results as a by-product of methane drainage programs. Mine owners are presently able to sell the high quality portion of their gas to pipelines after simple processing steps. Much of the drained gas, however, is a mixture of air, carbon dioxide, and moisture, with methane ranging from 30 to 90 percent. While developers can employ end uses that combust the gas directly (e.g. as supplemental fuel in local boilers or fuel for gas turbine-generators or internal combustion engines for the production of electricity), such projects may not be the most ideal. The industry has been searching for a proven and affordable solution to upgrade gob gas to about 97 percent methane so that they can take advantage of new markets offered by extensive natural gas pipeline systems. Enrichment plants have been operating successfully for years on low-grade methane from natural gas wells. At least one company is in the process of developing a commercial scale plant that removes all four gob gas contaminants in the same integrated facility.

CMOP hopes that the information and analysis contained in the report will help bring together the gas processing industry and those who wish to profitably use gob gas. In addition to conserving natural resources, projects that use gob gas are protecting the environment. Methane (on an equivalent mass basis) contained in the gob gas is 21 times as potent a greenhouse gas as carbon dioxide. Using gob gas as a fuel reduces its global warming effect significantly.

Technologies Examined

The nitrogen rejection unit (NRU) is the most critical and expensive component of any enrichment system. The study assessed three potentially suitable NRU technologies: 1) cryogenics, 2) selective absorption, and 3) pressure swing adsorption (PSA). The following describes each of the processes:

1. The cryogenics process pressurizes and flashes the feed gas stream and then uses a series of heat exchangers to liquefy the gas mixture. A distillation separator vents a nitrogen-rich stream, leaving the methane-rich stream.

2. Selective absorption uses specific solvents that have different absorption capacities with respect to different gas species. The petroleum refining industry commonly uses this method to enrich gas streams.

3. PSA systems repeatedly pressurize the gob gas and use molecular sieves to selectively adsorb nitrogen and methane at different rates. During successive cycles, the process preferentially adsorbs methane in favor of nitrogen until the output attains the desired methane proportion.

The study identified at least one commercial vendor for each of the three NRU technologies. Processes to remove the other three contaminants: oxygen, carbon dioxide, and water vapor are commercially available from many established suppliers using a number of different techniques. An integrated enrichment plant supplier most likely will be an NRU vendor and would select and take overall responsibility for these other systems.

The technical assessment described and modeled a preferred integrated facility configuration for each of the three systems. With the cryogenic and selective absorption NRU's, deoxygenation must precede all other process steps, but the PSA unit may precede deoxygenation because nitrogen and oxygen will separate from methane in the same proportion in a PSA NRU.

Technical Assessment

Even though the individual technologies for rejecting nitrogen, carbon dioxide, oxygen, and water may be considered "established", a system comprising all of the four processes working together on constantly varying gob gas flow and quality has not operated continuously at commercial scale. The study cites some progress during field trials of small PSA systems at two locations. These experiences encouraged developers to continue development, but also made it clear that building an integrated process to remove all contaminants from a variable feed gas will not be a simple task.

The technical assessment removed many of the doubts about the three nitrogen rejection techniques, and it concluded that any of the processes could perform as the principal component of an integrated plant to enrich gob gas. Any of the systems, but especially a cryogenics unit, would present explosion risks due to the presence of methane/air mixtures. System designers must build in sufficient safeguards to remove such risks. Remaining challenges, such as design of suitable control systems and maintaining feed gas specifications, appear to require only sufficient engineering and field trials.

Results of Cost Estimates

The analysis consists of estimating capital and operating costs for a range of feed gas flows (3 to 6 million standard cubic feet per day (mmscfd)) and qualities (50 to 90 percent) and expressing the results in terms of dollars per million British thermal units (mmBtu). Many of the cases show costs well below the current sales value of natural gas and indicate the potential for profitable projects. As expected, the results demonstrate that enrichment becomes more affordable with higher available gas flows and higher input qualities. Figure 1 plots the estimated (low-end) cost of enrichment versus the quantity of gob gas flow in mmscfd. Figure 2 plots low-end enrichment cost versus the quality of feed gas in percent methane.

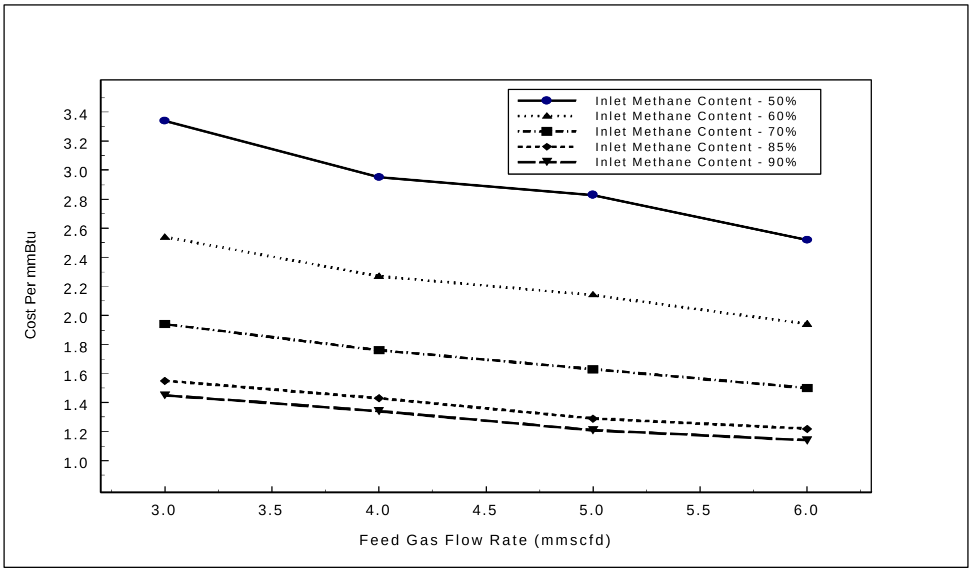

Figure 1: Low-end Costs versus Feed Gas Flow Rate

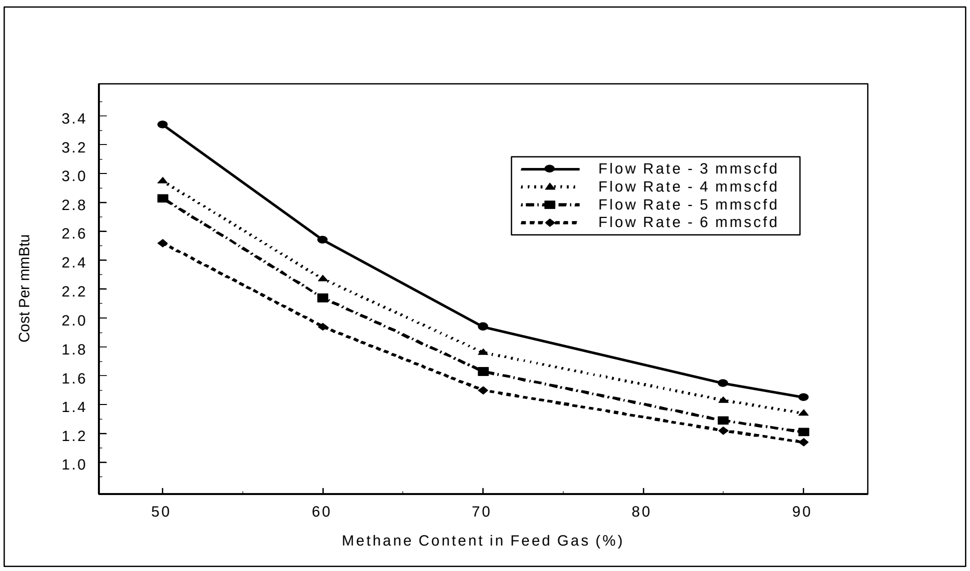

Figure 2: Low-end Costs versus Methane Concentrations in the Feed Gas

Profitability

The report selected three cases for additional analysis to learn how much profit might accrue to a developer who installs and operates an enrichment plant and sells the methane for $1.70 per mmBtu. Table 1 summarizes the internal rates of return (IRR's) for the three cases.

Input quality (% methane)	Plant size (mmscfd)	IRR (%)
85	5	26
85	6	33
70	5	22

Table 1: IRR for Three Selected Gob Gas Enrichment Cases

These results show that it is possible to earn an attractive rate of return with 85 percent feed gas even when gas prices are no higher than the assumed $1.70 per mmBtu.

Other Upgrading Options

Coal mine operators have three other options besides enrichment to bring their gob gas up to pipeline quality. They may use these options separately or in combination.

1. First, they may invest in techniques designed to *improve recovery* so that the gob gas maintains the highest possible quality standard. Some methods involve engineering designs that optimize gob well and borehole configurations so that less air is drawn into the gob area. Also, installation of monitoring and control systems will assist miners to reduce flow from wells that pull too much air.

2. Another option, possibly following the enrichment step, is *blending with high quality methane* (if available). One natural gas producer with high quality gas is considering the introduction of controlled quantities of medium quality gob gas into the gathering system. Blending would occur in the lines before reaching the point of sale.

3. A final option is *spiking* with higher hydrocarbon gases such as propane to bring the mixture to the minimum Btu value required by the receiving pipeline. This option may have limited application if the customer has strict specifications on the percentage of inert gases (nitrogen, carbon dioxide, etc.) contained in the mixture.

CMOP prepared a user-friendly computer program that helps gas project developers to identify cost-effective combinations of the various upgrade options. Copies of the program, which are available from CMOP, allow the user to input case specific operating and market parameters. The program displays the approximate unit cost of optimum and alternative configurations.

Conclusion

As summarized in this fact sheet, gas processing vendors soon expect to be offering integrated gob gas enrichment systems that project developers may employ to profitably upgrade medium quality gob gas to pipeline quality. The report suggests that gob gas enrichment is technically feasible and, under several circumstances, will cost less than the market value of the purified methane product. Developers may also be able to take advantage of other upgrade options such as, monitoring, blending, and spiking to reduce the overall production cost of high quality gas.

For More Information:

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